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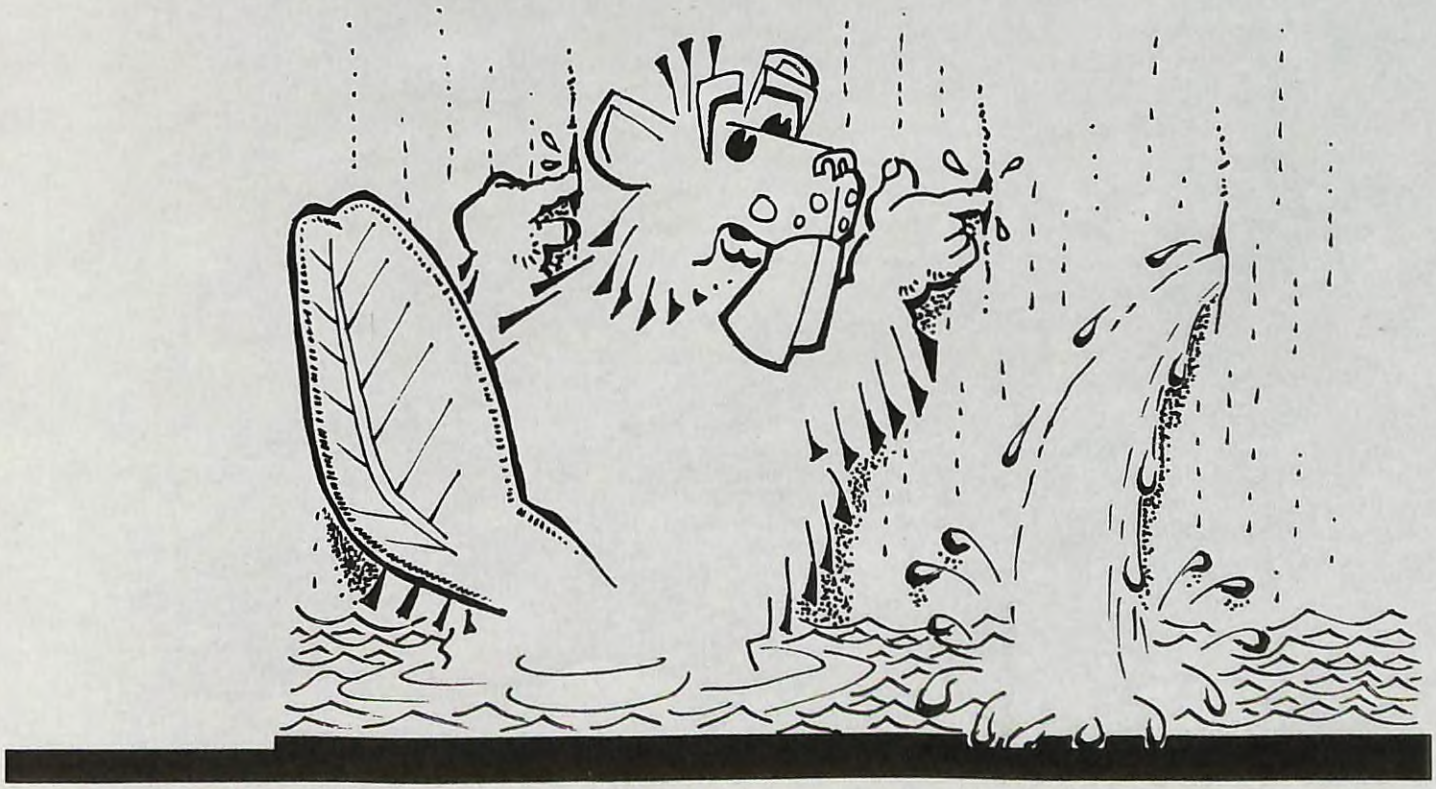
Better Basements



From the Editor . . .

Today we and our customers expect much more in our housing. The systems we incorporate into houses are much more sophisticated than even a decade ago. Our homes are much more complex than the post-war homes of the 1950s and early 1960s that were built largely by the contractor Generally, the only outside sub-trades would have been the electrician, plumber and heating contractor; otherwise, all the work was done by the same crew. Relatively few components were manufactured off-site; even the windows were site-assembled.

In other parts of the world, where Canadian housing is being introduced, the contractors still tend to be generalists and do most of the tasks themselves. This means that the contractor is expected to have a wide set of skills on his crew. In contrast, in Canada we now tend to contract out many tasks to specialists.

Even simple tasks have become specialized sub-trades, done by crews whose primary activity is narrowly focused on a single task. This offers the possibility of well-built, speedy construction, but it does put more responsibility on the builder who has to coordinate a multitude of outside contractors and their crews, especially when their work overlaps. Specialization has its merits in that we have highly skilled specialists. The downside is that many lose sight of the project's overall scope. Issues arise because of coordination between trades.

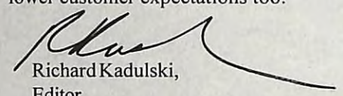
This becomes a concern especially in larger population centres experiencing the pressures of the current construction boom, where trades are at a premium. These busy times lead to the temptation to cut corners, either because one can get away with it or because of pressures to get the job done quickly. Too often it is a seller's market and the builder is told to take it or leave it. Other times, it is the builder or owner pressuring the trade to lower the price or to speed up the work. The consequence of excessive shortcuts is that it reinforces the image that too many consumers have of a construction industry that is not reputable.

I was disappointed recently to encounter a project where the mechanical contractor simply followed the most expedient route to laying out a ventilation system, rather than following the correct one. As installed, the ventilation system was not compliant with the CSA ventilation standard (and building code), and the contractor acknowledged as much. He explained his decision by raising job-site layout concerns and pressures from the builder. Unfortunately, the builder was not aware of the issues related to a non-compliant system, and it is unlikely that the building inspector would catch the situation either.

At another location, I encountered a builder who knowingly did not install a code-complaint ventilation system in the house. He became concerned about the strong odours lingering in the house – emissions from the various finishing materials. Since this was a very expensive house built on spec, I questioned why he didn't put in a heat recovery ventilation system, which would have minimized his problem. His response was that he didn't feel the extra cost was warranted. Yet he complained about how the house was not getting any offers, and that the carrying charges alone were $8,000 per month. He couldn't quite get it that there may have been a connection between the indoor air quality and how he'd built the house.

If we really are going to maintain standards and build the best housing in the world as we claim we do, we've got to resist all temptations to cut corners. We must insist that whatever needs to be done be done correctly. This means sub-trades must resist the temptation to cut corners simply because they can, or because the builder is pressuring them to. Similarly, builders must insist on performing tasks correctly, and resist either the sub-trade's or owner's pressures to cut corners.

We need to recognize that doing a job correctly may take a bit more effort. It may be difficult, but we must learn to communicate this to our customers. If we don't want to build disposable housing with a lifespan only as long as the mortgage period, we must do the right things. It may mean we have to lower customer expectations too.



Richard Kadulski,
Editor

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Building Better Basements

by John Staube and Richard Kadulski

Basements are a major source of problems in a house. They can be wet, musty, cold and a source of indoor air quality contaminants. Traditionally, basements were dug because the foundations had to go below the frost line and the excavated area provided a convenient cellar storage area as well as a coal bin.

Today's basements are being used for or converted into finished living space. The laundry, mechanical equipment and storage space no longer need automatically to be placed in the basement. Increasingly, there is an expectation for the basement to offer a high quality space. The difference is that it may be space that is finished at a later date. Regrettably, we still tend to build our basements as if they were unfinished cellars.

It is worth reviewing what forces act on the basement. The basement must support the structure, and deal with earthquake and wind loads as well as structural loads for the whole house. These loads are generally well understood. But basement assemblies must also control heat flows, which are not as extreme as above grade, as well as air and moisture movement. These below grade loads are not well understood. Moisture movement, by vapour drive and liquid water leakage, can be significant below ground. Air pressure differences may not be extreme below grade, but any pressure differential can drive soil gasses, radon and moisture into the house, affecting indoor air quality.

Moisture Control

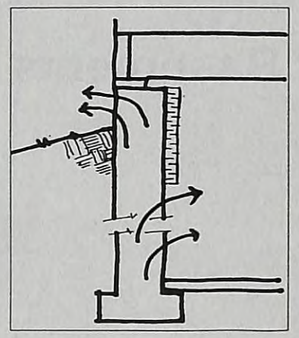
Water is the major cause of most failures in a house. It causes mould growth and leads to the decay of wood materials (basement framing, rim joists, etc.). Controlling moisture requires an understanding of where the moisture is coming from. We need to realize that moisture flows in a basement are different than they are in above ground construction assemblies. Moisture problems are not always the result of leaks or ground water, but also of ambient moisture. There are three main sources: exterior water, interior moisture sources, and moisture that is built in during construction.

Exterior water can be from above grade and below grade sources. Above grade moisture is handled through attention to building design and construction details to deflect water away from the foundation. These include reasonable building overhangs, good eaves troughs and down spouts to move rain water away from the house, properly sloped backfill against the foundation to ensure any moisture will drain away from the house, as well as adequate perimeter drain tiles.

Good building practice and building codes require a freely draining backfill material to reduce water pressures on the concrete foundation wall. That is the benefit of the variety of foundation drainage materials now on the market. These create a capillary break between the soil and the concrete. They are available as dimpled sheets or as semi rigid fibrous sheets, applied against the foundation. The foundation drainage treatment is an important part of exterior moisture management, removing moisture loading from the foundation.

The location of the water table is another important consideration. Common sense tells us that basements should never be built in areas with a high water table or subject to regular flooding. Unfortunately, basements too often are built in both high-risk areas. It is possible to detail waterproof assemblies, and manage water levels, but at a high cost, and with a high risk of at least periodic failure.

Moisture built into the construction assembly is often overlooked or misunderstood. Water is a key ingredient in concrete, mortar and many finishing processes. Additional moisture will be added during the construction process each time it rains or snows. Even kiln-dried lumber contains excess moisture that needs to dry out over time. That is why it is best to delay finish-



In an unfinished bassement, the initial drying can be toward the inside and outside. Below grade it is limited to the interior only since the soil itself is wet.

ing the interior of the basement. Equally important is to ensure that concrete mixes use as little water as needed.

Drying can take place to the exterior or the interior of basement construction assemblies. Concrete contains 25 to 50 litres of water for each cubic metre of concrete. In addition, the excavation will collect water during the construction process, and this water can be absorbed by the concrete through the footings. Capillary forces in the concrete keep moisture in the concrete, and also suck in any free water that comes in contact with the concrete, so that the concrete also acts as a rigid sponge which in turn becomes a moisture source.

The backfill materials and the soil against the foundation are always wet and cool, so the concrete foundation walls cannot dry into the soil. The only paths available are to the outside through the exposed portions of the foundation wall and to the interior. To deal with these conditions, the wall assembly requires low-permeance interior finishes, semi-permeable insulation, and a smart vapour barrier.

When adding insulation in a basement retrofit, placing a capillary break on the interior against the foundation wall may be an appropriate compromise to consider, since it may not be practical to dig up the soil around the house to install a new exterior drainage layer.

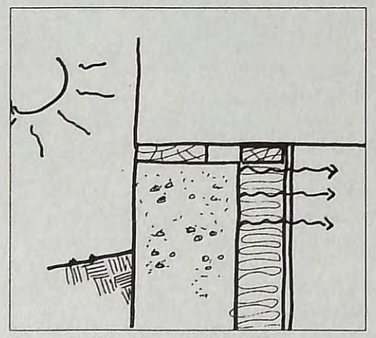
Interior moisture sources are also important in the basement because the temperature conditions will be conducive to condensation at certain times of the year. Humidity levels can be controlled by winter ventilation and summer dehumidification. At all times there must be control against flooding through floor drains and at appliances.

It is also important to remember that there are significant temperature gradients in the soil. The top of the foundation wall will experience different heat loss and temperatures than the bottom of the wall.

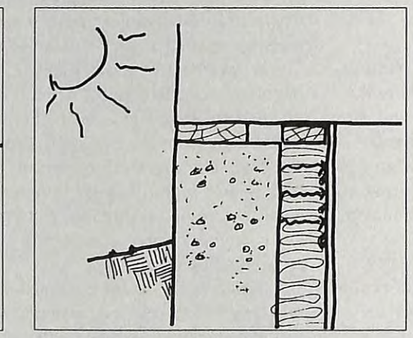
Basement Moisture Movement

It is important to remember that vapour moves by diffusion and air movement. Water vapour movement by diffusion always moves from more to less. In other words, from a wetter to a dryer area. That is why it is important to place the vapour retarder on the moist side (i.e., area with the higher vapour pressure) to control vapour diffusion.

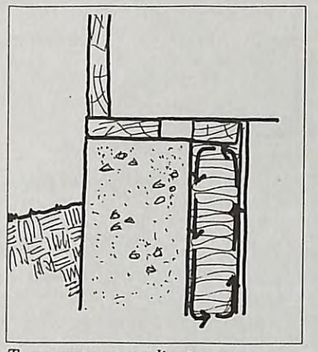
Since soil is wet most of the time (at 100% relative humidity), the vapour drive is almost always inward across the entire foundation wall except near the top of the basement wall during winter in humid houses. That is why we should be placing the vapour barrier on the outside of the basement wall. However, standard practice is to put a vapour barrier (usually a polyethylene sheet) on the inside of the concrete foundation wall, and then another layer is placed just before applying the drywall or panelling. As a result, moisture moving by diffusion from the drying concrete and soil is trapped by the interior vapour barriers.



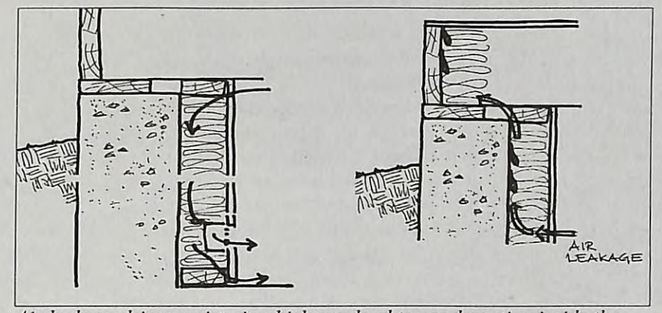
Inward diffusion at Grade. Higher temperatures on the exterior drives moisture inward. Drying can take place if the interior finishes are somewhat permeable, as the vapour dries inside.



Inward Diffusion as Grade. Higher temperatures on the exterior drives moisture inward. If the interior finishes are impermeable (e.g., if there is polyethylene under the drywall) drying to the inside cannot happen, so that condensation can take place inside the wall assembly.



Temperature gradients can generate air movement due to stack action, especially when there are gaps in the insulation.



Air leakage drives moist air which can lead to condensation inside the assembly.

The bituminous damp proofing applied to concrete walls is neither a vapour barrier nor waterproofing, and will not stop water penetration. It merely seals the smallest capillary pores in the concrete, and retards ground moisture movement into the concrete.

Water vapour also moves with air flow, moving from an area of high to one of low pressure. Any moist air that reaches a cold surface will result in condensation. To control moisture movement by air leakage, it is important to stop air flow or to ensure that any air flow only comes from the dry side. This requires a good air barrier, as well as avoiding air loops within the insulated assemblies.

Common problems in basement walls are the air spaces within a furred wall which are caused by the way insulation is installed. Unless the insulation is a blown-in material, or fibrous batts are perfectly installed to leave no voids, there will gaps in the insulation around the furring on both sides of the batt. These air spaces allow air currents to develop, because the temperature difference between the warm inside and cold outside of the insulation. Warm air will rise in the interior channels drawing cold air down against the concrete so that a convection current is generated by stack action within the wall. Because of the constant cool temperatures in the ground, these convention currents in the basement walls can be significant for long periods of the year - both in summer and winter. At various times the air will encounter surfaces that are below the dew point temperature, leading to condensation within the wall.

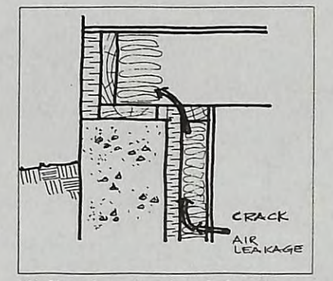
Understanding these concerns will help us understand what a durable foundation detail looks like. It requires the use of water tolerant materials and an air tight assembly.

A good example is shown in the figure on the next page.

On the exterior, there will be a manufactured drainage layer or free draining material. The drainage layer could be applied over rigid insulation.

On the interior, there will be rigid insulation, such as expanded polystyrene insulation applied directly to the concrete. Furring for interior finishes will be placed inside of the rigid insulation, which could also include additional insulation such as fibrous batts. The interior drywall finish would be applied directly over the furring, with careful attention to sealing all joints and connections to ensure an airtight assembly. No polyethylene vapour barrier should be used here, but just paint.

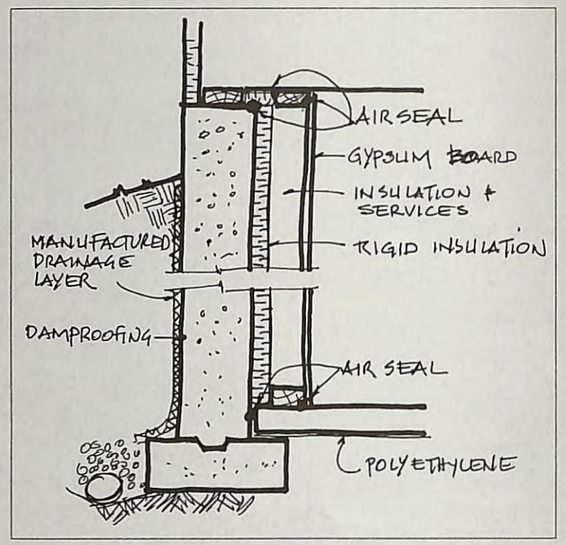
An alternative to the rigid insulation applied to the interior of the foundation wall would be using a vapour permeable spray-in-place foam insulation, such as Icynene or Demilec. This results in a well insulated but somewhat vapour permeable assembly that is then able to deal with



Wall with an insulated sheathing raises the temperature of the first condensing plane, eliminating or reducing the potential for condensation within the construction assembly.

the small amount of water vapour movement that can occur seasonally.

Provided proper attention is given to the details to ensure an airtight assembly, these details apply sound building science principles for a durable construction assembly and meet the intent of the Building Code. In many respects, these details are substantially the same basement details as those achieved with insulated concrete forming systems (ICFs). It must be stressed, however, that if the foundation is located in a flood plain or at or below the water table, even these details will not prevent moisture-related problems. ☼



Good basement detail: Layer of rigid foam insulation or spray foam insulation against concrete. Careful attention to air sealing assembly. No polyethylene either against concrete or behind gypsum board. Vapour diffusion resistance on inside provided by painted drywall.

Dr John Straube is Assistant Professor, University of Waterloo Building Engineering Group. Copies of his presentation ***Basements - Getting them Right*** *are available at: http://www.civil.uwaterloo.ca/beg/presentations.htm*

Strange but true . . .

There are consequences to improperly designed or maintained equipment.

We recently heard about a boiler that was not tuned properly, so was producing high levels of carbon monoxide in the flue gases. The occupants of the building were not directly affected because the gases were being vented out the flue. However, birds liked to congregate at the top of the flue to take advantage of the warmth in cold weather. Unfortunately, the elevated CO levels were killing them off, but no one noticed because the dying birds were falling into the flue. It was only when the pile of dead birds blocked the vent that the improperly tuned boiler was noticed.

The standard for heat recovery ventilators requires that the fresh air supply grille be installed no less than 18" above finished grade, and that the vent have an insect screen. Some builders have found it convenient to locate the inlet grille high up on the wall or even on the roof. However, since such a location may be difficult to access, they remove the insect screen to prevent it from getting plugged with leaves and debris.

We've recently heard about a nasty surprise the homeowner received when he went to clean his HRV filters. It seems that a couple of birds managed to get into the ducts, fell into the HRV and were unable to get back out. Unlike the usual mass of dead insects kept out of the house by the HRV filters, he also had a couple of dead birds to deal with.

Compliance with standards may be a challenge at times, but proper procedures and standards are generally drafted for a reason.

Fasteners for Treated Wood

Metal connectors, anchors, and fasteners will corrode and lose their load carrying capacity when installed in corrosive environments or exposed to corrosive materials. Corrosion can be caused by ocean salt air, wood treatments for preservation or fire protection, fertilizers, dissimilar metals and moisture.

There are many variables in a single building, so it is impossible to accurately predict if or when corrosion will begin or reach a critical level. That is why users must be aware of the potential risks and select a coating product or metal suitable for its intended use. It is also important that regular maintenance and periodic inspections be done especially for outdoor applications.

It is common to see some corrosion on connectors, fasteners and anchors, especially in outdoor applications. Even stainless steel can corrode. Minor corrosion will not severely affect the performance of a fastener. If significant corrosion is apparent or suspected, then the wood, fasteners and connectors should be inspected by a qualified specialist and may have to be replaced.

Changes in the preservative-treated wood industry since the beginning of 2004 have created concerns. The standard preservative treatment was chromated copper arsenate (CCA-C). Recently, the preservative-treatment industry voluntarily moved from CCA-C to alternative treatments, such as alkaline copper quat (ACQ) and copper azole (CA). Testing has shown that these replacement treatments are generally significantly more corrosive to steel than CCA-C, so the use of treated wood requires special attention to the use of proper fasteners

Understanding which fasteners and anchors to use with these materials has become a complex task due to the different pressure treatment formulations, varying retention levels, and because the formulations may vary regionally or can change without warning

The treatment industry points out that ACQ and CA treatments have been used in Europe and Japan for more than 15 years without the type of fastener corrosion problems being observed in Canada today. In part this could be because in Europe and Japan wood is considered a more precious material so more substantial, expensive and appropriate fasteners are used.

CCA itself was also corrosive, but the treatment had corrosion inhibitors added. However, ACQ and CA treatments do not have any added corrosion inhibitors. Actually, it is the solvents used to transport the treatment chemicals that have a high potential for corrosion. The treatment industry is still experimenting with the new treatments and procedures, so this may affect chemical concentrations and curing properties. The kind of wood is also a factor, as some types of wood are better at absorbing the preservative treatments than others.

Although CCA registration for use in residen tial construction has been removed, it is still used in commercial applications, and could be used in exterior applications.

The construction materials distribution system is another challenge. Too often the point of information for the builder is the local building materials distributor, but they may not have the knowledge or information required. Even in the age of the Internet, all information may not be readily accessible –in the guise needing to protect commercially sensitive information.

So the question remains: What are the appropriate fasteners to use with treated wood?

For years the treated wood industry has recommended the use of stainless steel or hot-dip galvanized fasteners and connectors. This recommendation is still the same for use with the new treatments. However, more clarification is needed to ensure that adequate corrosion protection is provided. Just specifying hot-dipped galvanized products is too generic as there are different thicknesses of galvanized coatings that will result in different levels of protection to the steel. Not being specific regarding the amount of hot-dip galvanizing

ACQ treated wood is twice as corrosive as CCA treated wood . . . so the connectors used with ACQ must offer at least double the protection. . . . If there is any doubt, use stainless steel connectors and fasteners.

protection can lead to the use of products which may not be good enough.

Simpson Strong Tie, the major manufacturer of fasteners, connectors and anchors, has been doing considerable research with preservative treated wood in order to refine their products. They have observed that treatment plants are still varying the formulations of their treatments without advising users. Consequently there can be significant variations between different batches of treated lumber.

The corrosion protection of a hot-dip galvanized product is a function of the amount of zinc on its surface. Simply put, more zinc means better performance. Historically the connector industry has used products manufactured with a G60 coating, which means 0.60 oz/ft² of zinc continuously applied to a steel coil. Simpson Strong Tie recently increased their minimum standard to a G90 coating (0.9007 /ft²). They also produce many products with their ZMAX™ label, which is a G185 coating (1.85 oz/ft²).

Testing has also shown that type 304 and 316 stainless steel products corrode substantially less than other alternatives when used with the alternative wood treatments. Simpson now recommends the use of stainless steel as the most effective solution to corrosion risk. However, stainless is also a more expensive product and sometimes more difficult to obtain.

Because increased corrosion from some pressure-treated woods is a new issue with little historical data, Simpson Strong Tie has being doing their own testing with a variety of wood and fastener samples. Their recommendations are based on their experience and tests. They state in their technical bulletin that it is possible that, as more is learned about connector performance, their recommendations may change. In fact, their technical bulletin (Preservative Treated Wood at - *www.strongtie.com*) carries a best-before date. It "should not be relied upon after Jan. 31, 2006."

The number of variables that affect the rate of corrosion makes it impossible to apply Simpson's test results to all product combinations, installation details and environmental conditions, nor can their results be correlated to service life. They are an average of the result of G90 and G185 continuous hot-dipped galvanized steel samples and are based on accelerated testing that may not have a direct relation to actual service life.

The tests do show the average tested relative corrosiveness of several treatments compared to the corrosion which occurred with CCA-C treated wood. ACQ-D treated wood is on average twice as corrosive as CCA-C treated wood. This suggests that there needs to be at least double the coating protection for connectors used with ACQ-D treated wood. Borate treated wood generally has a lower corrosion rate than with CCA-C treated wood.

Treatments with ammonia carriers were not included in this testing. Preservatives with an ammonia base (carrier) are known to be more corrosive.

Is there a best connector to use? This is a case where minimum code standards will not provide adequate guidance. Much depends on where and how the connector is to be used. It is important to evaluate the environment in which the connector is placed. Is it an interior or exterior application? Is the environment dry or wet? Is it a high or low risk environment?

A suitable pressure-treated wood for the intended application and environment must be used. The treated wood supplier should provide all the information needed regarding the wood being used. This information should include: the specific type of wood treatment used, if ammonia was used in the treatment, and the chemical retention level as well as a connector coating or material recommendation.

If the needed information is not provided, in their literature Simpson Strong Tie recommends using stainless steel connectors and fasteners. They have also prepared a table suggesting the types of connectors to use based on the environment and type of treatment. If there are any doubts, then the most conservative recommendation should be used.☼

For more information on treated wood products:
Canadian Institute of Treated Wood
www.citw.org
Osmose Nature Wood®
*www.osmose.com/acrobat/*NaturewoodFastenerInfoSheet.pdf
Preserve® or Preserve Plus® (built-in water repellent)
www.treatedwood.com/fastener.pdf
Wolmanized® Residential Outdoor® Wood
www.wolmanizedwood.com/fasteners.htm
Tim-bor® Industrial
www.borax.com/wood

For information on fasteners:
Simpson Strong Tie
www.strongtie.com
International Staple, Nail, And Tool Association
www.isanta.org
USP Structural Connectors
www.uspconnectors.com

A picture is worth a thousand words: a high performance window and a standard clear glass window in the same environment.

Condensation – As It Applies to Your Windows

C. Gould

Condensation occurs when a material goes from a less to a more dense state. In the case of water, condensation forms when water vapour turns into a liquid. For condensation to form, the air that is next to a surface must have a dew point that is the same as or higher than the surface's temperature.

An example of this is a glass containing a cold beverage on a warm day. There will be condensation on the exterior of the glass because the glass has cooled the air directly next it. The air's ability to hold water is reduced and its dew point is higher than the surface of the glass, causing water to precipitate out onto the glass.

If we wanted to change the conditions so that the glass stayed dry we would have to change the relationship between the dew point of the air next to the glass and the temperature of the glass. As long as the dew point is lower than the temperature of the surface of the glass, the glass will stay dry. To change the dew point of the air, we would have to change the air's ability to hold water. We could do this by warming the air or by reducing the amount of water in the air, or a combination of both. We could also warm the glass so it is warmer than the dew point of the air next to it.

Another term used to describe the water content in air is relative humidity. Relative humidity is a percentage of the maximum amount of water that air can hold at a specific temperature and pressure. For example, if a given volume of air could hold 10 grams of water at a temperature and pressure but only has five grams of water, then it is said to be at 50% relative humidity. We could change the relative humidity of this volume of air by either warming or cooling it at constant pressures. If we cool the air we will raise its relative humidity and also its dew point. On the other hand, if we warm the air we will cause the relative humidity to drop and lower the dew point temperature.

How does all this affect windows? If the air next to a window has a dew point temperature that is higher than the window glass, the air will deposit water onto the glass until its dew point is the same as the glass.

So how do we control condensation onto the window glass? We either have to warm the surface of the glass, or lower the relative humidity of the air so the air's dew point is lower than the surface temperature of the glass. There are several ways to do this:

- Use window glass that is a better insulator so the glazing unit does not lose heat as fast and the glass surface is easier to keep warm. High performance glass will lose heat more slowly than regular clear glass. But it still does lose heat, so heat is needed to keep the surface of the glass above the dew point

R-2000

For information on the R-2000 Program, contact your local program office, or call 1-800-387-2000 www.R-2000.ca

temperature of the air. However, high performance glass needs less heat it to keep it above the dew point.
- Reduce the relative humidity of the air next to the glass.

Lifestyle also influences the conditions in a house. If a part of the home is kept cool, the air in that part will have a higher relative humidity and will experience a rise in its dew point. This will mean that any surface with a temperature at or below the air's dew point temperature will have condensation on it. This could be a room that is closed off or one with a lower temperature setting (especially in zoned heating systems, such as homes with electric baseboards) and allowed to cool. This could also be the area next to a window behind tight drapes or blinds. Drapes not only trap the air and allow it to cool; they also provide insulation so that warmth from the room is prevented from getting to the window surface to warm the surface of the glass. This is why condensation on windows is seen so often on windows when drapes are opened.

- Simply open the window a crack. This allows outside air to displace the cooled room air because the relative humidity of the outside air is lower than the room air that would have been trapped behind the drapes or blinds and allowed to cool to almost outside temperature. However, this does come at an energy cost, and is only a practical possibility in the mildest climate zones. It also explains why, in renovations, when new windows are installed and the air leakage around the windows is reduced, there is an increase in window condensation.

- Allow or promote air movement up against the window to both warm the window surface and keep warmer house air with a lower relative humidity next to the glass. This is one reason why heating registers are normally placed on the outside wall, under the window.

Condensation is not restricted to the interior of a building. It also happens on cool outside surfaces of a building where air with a high relative humidity (and high enough dew point compared to the surfaces the humid air) comes in contact with it just like it does on a car. This is more apparent on high performance windows because the glass reflects more heat back into the room and so the outer surface of the glass is cooler.

If you want to control or reduce condensation in your home, you have to control the balance of the dew point temperature of the air and the temperature of the surfaces that come in contact with that air. To control the dew point of the air, it is necessary to control its water content and temperature. You can keep heating the air to lower the relative humidity, probably well beyond where the home is comfortable, or lower the air's water content. Lowering the water content of a home's air can be done with a properly designed continuous ventilation system that will bring cooler, drier air from outside. This outside air will need to be heated, but the incoming air dilutes the existing air and lowers the overall relative humidity. A heat recovery ventilator reduces the energy penalty.

It is also important to keep the surfaces in your home above the dew point. This means keeping the heat loss of surfaces in the room in balance with the heat gains they have, so that the objects stay above the dew point. In the case of windows, this usually means a source of warm air to replace heat lost to the exterior. The rate of heat loss can be reduced by using high performance glazing and window frame products.

Keeping in mind the physics of how condensation forms in your home will go a long way in helping you reduce condensation in your home. ☼

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Letters to the Editor

Re: Geothermal as Green Heating Source, Solplan Review No. 121, March 2005

These days it takes me a long time to catch up on my reading, if ever. I did finally get around to reading the March Solplan review and just wanted to say thanks for the short article on Geothermal as a "green" heating source. It is an article that has been needed for a while to bring a sense of perspective to geothermal and I'm glad you did it. Nicely put.

Alex Zimmerman
President, Canada Green Building Council
Victoria, BC

I wanted to underscore your insistence (March issue) that energy demand must be reduced as much as possible before installing a geo-x system; most of our dealers will not install into a leaky envelope because it's counter-productive to what we try to achieve. Also, don't forget that geo-x systems provide the 20% load for domestic water heating, and a number of owners purchase "green tags" to offset greenhouse gas emissions if they're on a "dirty" grid.

On your concern over the potential for excessive heat extraction and subsequent frost build-up, the purpose of CSA C448 is to provide design and installation guidance to ensure that this scenario doesn't happen. Unfortunately, this national standard is not invoked by regulatory agencies, which ties in with your lead editorial on the perils of ignoring regulations that are designed to protect consumers. In a recent analysis of the Ontario market for the David Suzuki Foundation, the conclusion was that geo-x technology can have a significant impact on natural gas combustion and on baseload electricity supply. Addressing these two factors does make our technology one which should . . . at least . . . be evaluated in any conservation and construction practice.

Bill Eggertson
Earth Energy Society of Canada
Ottawa

As a loyal reader of Solplan Review, resident in Toronto and designer of ground source systems, your article is very valid for the specific purpose it was written for, but limited in the opportunity ground source potential affords for buildings with high performance envelopes. I would like to raise three issues not developed in your article:

In many regions of Canada cooling loads are more significant than in Vancouver - and will get more significant everywhere with global warming. Therefore, heating-only ground source installations may increasingly disappear.

Strictly speaking, geothermal energy is the opportunity to obtain free energy from the large thermal storage in the ground, providing thermal conditions moderated from ambient extreme temperatures. Being somewhat of a pedant, your article is about "heat-pump assisted geothermal energy" presumably via forced air delivery, although geothermal energy, such as space cooling and ventilation preheat can be supplied without heat pump operation. I would also like to direct readers to my article from a previous Solplan issue entitled "Silent Running" (Solplan Review No. 105, July 2002) which introduces the more efficient and ground source compatible concept of ceiling hydronic radiant cooling. Virtually all the projects we design now use this approach.

You did not recognize the open-well installations which, if the two wells are adequately separated, have no problem with heating-only heat pump operation. The separation is difficult to achieve in urban contexts, but clearly a significant proportion of ground source heat pump installations are on properties that are sufficiently large to use this heat exchange option which can be the lowest cost.

In summary, our challenge is to maximize the free ground energy and minimize the run-time of the heat pump. One way to express our philosophy is that there is great opportunity in ground heat exchangers while heat pumps are useful energy conversion devices. But like a car, it's most energy efficient when it is parked.

Mario Kani, P.Eng
Partner, Sustainable Edge Ltd.
Toronto

Technical Research Committee News

Canadian Home Builders' Association

National Building Code Training

The next edition of the National Building Code is about to be published, and will be in force in most regions in 2006. The Institute for Research in Construction (IRC) will hold regional workshops on the technical changes to the Code starting in December.

A training package for building officials on the effective use of the Objective-based Code for alternative solutions was developed by an IRC multi-stakeholder committee and is currently being field-tested. Earlier, CMHC had indicated some support to help develop a training package for builders and other industry professionals, but it appears that the Province of Ontario may be developing training for builders and others, in which case CMHC will not do so.

The need for separate "How to Comply" guides for the new ventilation and flashing requirements will be addressed by CMHC. There may also be a need for training in applying the new rain screen requirements that will apply in maritime areas.

Commissioning Mechanical Systems

Proper installation of mechanical systems is important in getting the most efficiency out of a heating and cooling system. Errors in installation and a failure to properly commission these systems are a key cause of many problems associated with them. This is why there has been so much stress on proper commissioning. However, there is a challenge in verifying all systems on the site without adding extra cost and time complications for the builder and the owner.

However, in the US there is talk of requiring on-site testing of cooling equipment and air-source heat pumps in order to obtain an Energy Star label on the equipment. CHBA has been asked by NRCan to comment on these US plans since the Energy Star label is also used in Canada. CHBA believes this would discourage adoption of energy-efficient equipment.

This is also one of many proposed third-party interventions that cumulatively could undermine the builder/customer transaction and unnecessarily increase builder liability.

Maintaining a Safe and Healthy House

CHBA believes there is a need for consumer-focused information on the hazards of improper use or modification of homes. Of concern are unvented fireplaces or heaters, but of special concern is the impact of the depressurization induced by large capacity exhaust appliances. These can induce back-drafting of combustion gases in combustion appliances as well as suction of soil gases into the house which will affect the indoor air quality.

In some cases, the conditions created by the operation of large exhaust fans could be lethal. Unfortunately, so far the concerns and their direct relationship to the equipment have not gotten through to some manufacturers, with the result that installing an interlocked make-up air package can be difficult.

The CMHC Home Owners' Manual is an excellent vehicle for this message and may need to be modified. However, since much of this equipment is not purchased at the time the home is being built, the connection may not be made, and homeowners will not check their owner's manual. That is why a stand-alone piece that can be distributed separately by renovators, equipment installers and even retailers would also be helpful.

Vinyl Siding and Solar Energy

There is a persistent myth abroad that, because Canada is a northern country, solar energy applications are at best marginal options only for enthusiasts and not worthy of serious consideration. Yet we know that solar can provide a significant amount of heating to a properly designed house, and also contribute a large portion of home's annual hot water needs as well electricity.

The amount of solar energy available is illustrated by the problem some builders are encountering of vinyl siding melting due to reflected sunlight in shoulder months when the sun angle is low. This could be the result of lightweight siding material not able to absorb the solar energy, as well as building and landscape design that concentrates the solar energy into a small area, generating high temperatures.

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.
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Tel: (613) 230-3060
Fax: (613) 232-8214
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www.chba.ca

Pay-As-You-Go Electricity

We buy the energy for our cars and trucks before we use it. As prices go up, we are more likely to pay attention to how well we use it. However, energy delivered to our home is one of the few things that most of us use before we pay for it.

In parts of the world, consumers are now paying for their household energy before they use it on a pay-as-you-go basis. It is a simple system where each consumer is provided with a Smart Meter that replaces their old style meter. In addition, the consumer receives a display unit that provides them with important information on energy use. Customers also get a Smart Card they use to buy energy in convenient amounts from a variety of local outlets, such as nearby gas stations, variety or food stores. Once they have purchased the amount of energy they want, they take the Smart Card to their display unit and insert it in the meter which communicates with the outside meter. The amount of energy purchased is now available for use.

The in-home display presents real-time information to the homeowner, such as how much electricity is being consumed currently, today, yesterday, last week and last month. Consumers gain valuable insight into their energy usage, which in turn empowers them to take control of their energy consumption and ultimately save money. They can see the consequences of their decisions immediately.

This approach has been pioneered in Canada since 1989 in Woodstock, Ontario. What has been learned is that the pay-as-you-go system of energy payment provides an important incentive to conserve energy. Customers in Woodstock have experienced 15 - 20 % savings on their energy bills compared with homes using traditional billing methods.

Because residential electricity consumption represents a significant percentage of Canada's greenhouse gas emissions, a wide-scale application of the pay-as-you-go system could reduce emissions substantially. This is one way that individuals can meaningfully participate in the One-Tonne Challenge being promoted by Natural Resources Canada, which is encouraging Canadians to reduce their individual greenhouse gas emissions by 20 % or one-tonne.

The pay-as-you-go approach is gaining momentum, as several local Ontario utilities are launching similar programs. Manitoba Hydro has just announced a one-year pay-as-you-go Smart Meter pilot program in five Manitoba communities, and ATCO Electric in Alberta is doing a controlled pilot in Drumheller and Grande Prairie.

ATCO is monitoring more than 400 households with smart meters and comparing them with 300 without meters, to ensure there are no outside influences on electrical consumption. The goal is to determine if this technology can produce the same energy savings in other communities as those found in Woodstock. ☼

Information:
www.infoenergy.net

NRCan Software Updates

HOT2 XP Version 2.72
HOT2000 Version 9.31

The latest versions of these software are now available for downloading from the Buildings Group website:
www.buildingsgroup.nrcan.gc.ca/software

The software incorporates corrections to a variety of bugs that have been identified by users. A list of the bugs and which ones have been corrected can be viewed on the web site.

HOT2XP is the software used for the Energuide program, both for the existing houses retrofit program and for the new houses program. HOT2000 is mainly used for R-2000 home certification, although it is also used in the Energuide program for more complex houses. HOT2000 is the more detailed software, and can also do room-by-room heating calculations.

Use of the latest versions will be required by the end of September 2005 for certification of R-2000 houses, and for Energuide labelling of homes.

The software is available for free to anyone who wishes to download it, but only trained and licenced persons are eligible to obtain a copy that calculates the Energuide for Houses number. ☼

Stair Safety

Stairs can be dangerous. In 2001 a total of 6, 224 Canadians fell on or from stairs or steps in their homes and were injured seriously enough to require a hospital visit. More than half of the 6, 224 people hospitalized were seniors. Whenever anyone falls on a stair, but especially if she or he is a senior, the consequences can be severe and long-lasting. With an aging population, stair safety becomes more important.

Professionals who study why people fall on stairs say health, environmental and behavioural reasons are contributing factors.

Health factors include eyesight problems, frailty, drowsiness, loss of balance and an inactive lifestyle.

Environmental factors include poor stair design, construction and maintenance; nonexistent or dysfunctional handrails; poor lighting; and other visual features of stairs such as the tread surfaces.

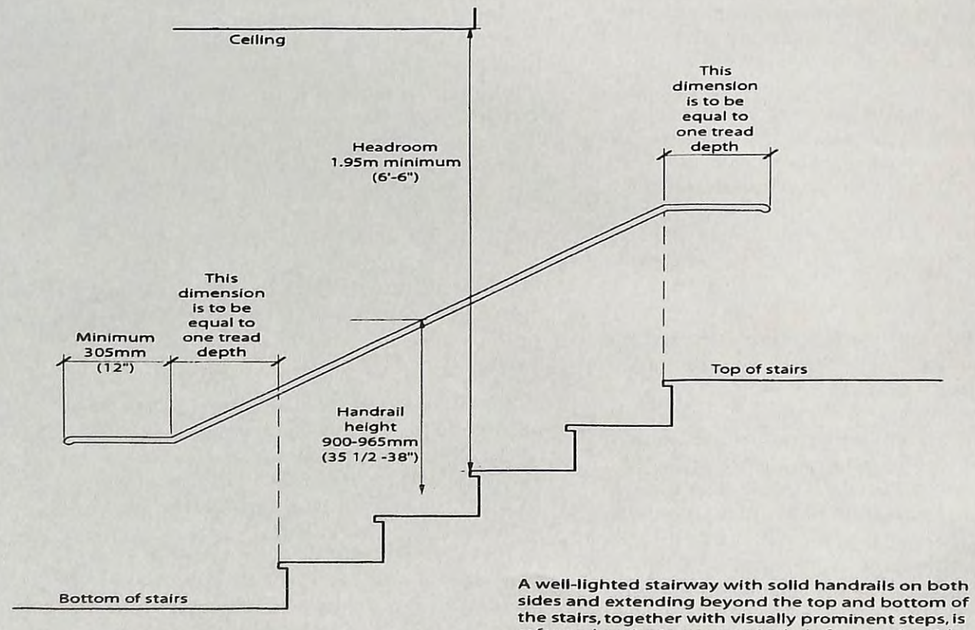
Behavioural factors include lack of concentration, carrying something while using stairs, unsuitable footwear, and unfamiliarity with the stairs (although most stair-related injuries occur on stairs the fall victim is familiar with.)

CMHC has published an About Your House consumer publication Preventing Falls on Stairs. Understanding the causes for falls will help ensure the strategies that prevent falls will be successful. Taking advantage of this information when building new homes, or doing major renovations, will help avoid building-in the problems.

Here are some of the design and construction tips contained in the publication:

Lighting

Poor lighting causes people to misjudge the presence and exact location of each step. The solution is to improve lighting and use lighting that makes tread nosings distinctly visible and does not glare on strong shadows. Also, make sure there is a light switch at both the bottom and the top of the stairs.

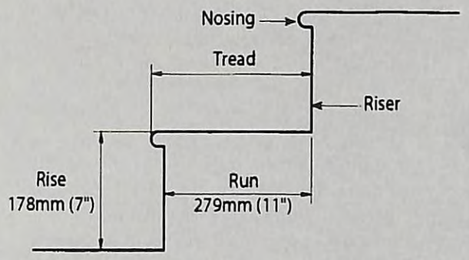


A well-lighted stairway with solid handrails on both sides and extending beyond the top and bottom of the stairs, together with visually prominent steps, is safer and easier to use, particularly for people with poor balance or vision.

Stair geometry

The National Building Code of Canada permits a maximum 7.87" (200 mm) and a minimum 4.9" (125 mm) rise; a maximum 14" (355 mm) and a minimum 8.26" (210 mm) run; and a maximum 14" (355 mm) and a minimum 9.25" (235 mm) tread depth; as well as a minimum headroom of 6'4 ¾" (1.95 m) along the length of the stairway within a home.

Professionals that study stairs advise that a rise not higher than 7 inches (178 mm) with a run not shorter than 11 inches (279 mm) to provide increased comfort and safety. There are cost and design implications of different step geometries which need to be considered.



Winding or curved stairs

Handrails should be provided on each side of the stairway especially where the stairway includes combinations of rectangular and tapered threads that require users to move from larger to smaller tread depths. Handrails are strongly recommended regardless if the number of steps on the stairs.

An adult should be able to wrap his or her hand around and underneath the handrails. Extend the hand rails, without a break, the full length of the stairs, and beyond the top and bottom of the stairs. Ensure handrails have a tactile indicator that warns users that the stair is coming to an end. Attach handrails securely to walls and posts.

Treads

Use a slip-resistant, rough finish on treads that are subject to wetting. Fasten tread coverings securely. The covering should be tight against the nosing. Resilient safety tread coverings must be carefully installed and maintained because they tend to crack at the nosing and become an additional hazard. ☼

About Your House fact sheets are available at www.cmhc.ca
(Click Shortcuts for... Individual consumer)

Do Large Homes Use More Resources?

Larger means economies of scale. We're told this daily by large corporate entities as they gobble themselves up, creating ever larger mergers. So one would expect that a larger house size could be justified by an economy of scale in terms of materials used - as house size increased the quantity of materials used per unit area of floor area would drop. However, that is not necessarily the case according to research at the US National Association of Home Builders (NAHB.)

Although NAHB has not compiled data on material use as a function of house size they believe that, because larger houses tend to have taller ceilings and more features, the larger houses consume proportionally more materials. They estimate that a new 5,000-square-foot house consumes three times as much material as the 2,082-square-foot house, even though its square footage is only 2.4 times as large.

Total wood use in houses has increased steadily between 1950 and 1992 as houses grew in size. When the total wood use per unit of floor area is reviewed, it dropped between 1950 and 1970 perhaps due to the substitution of plywood sheathing for board sheathing and the introduction of more wood-efficient framing practices and roof trusses. However, since about 1970 wood use in US homes, per square foot of floor area, began to increase so that by 1992 it was about 12% more than the low point. Exactly why this is occurring is not clear, but it could be a result of an increased use of 2x6s instead of 2x4s for wall framing, or a shift to more complex geometries. ☼

from: CABA Home and Building Automation Industry News - July 2005

Energy Answers

Rob Dumont

When will a peak in the world's conventional oil production or "Peak Oil" be reached?

Soon.

"Peak Oil" is a phrase that is becoming much more common these days. I googled "Peak Oil" and found 859,000 hits.

Peak Oil refers to the time that the oil production in the world will reach its highest value. In the lower 48 states of the US, Peak Oil production occurred about 1970. In 1999 the UK passed its peak. All oil fields eventually reach a state of Peak Oil.

Some sources suggest that Peak Oil for the world will occur within a very short period, and some are even suggesting that the world has already reached Peak Oil. The following graph presents the expected peak in about 2008. The graph was prepared by the Association for the Study of Peak Oil. (*www.peakoil.net*)

There are several points of interest on the graph. Note that the lowest line, representing the oil production from the US lower 48 states, which shows a peak about 1970. The drop in total oil production from 1979 (upper line) to about 1983 is also evident. The consumption drop was precipitated by the strong rise in the price of oil, by high interest rates, and the recession in those years. The peak in world oil production is expected to occur in about 2007 or 2008 according to this graph.

I was born in 1946. In my lifetime world oil production has increased from about 3 billion barrels a year to about 30 billion a year – a ten-fold expansion. Another ten-fold expansion is not possible.

But is the above graph showing a peak in oil production in the next few years believable?

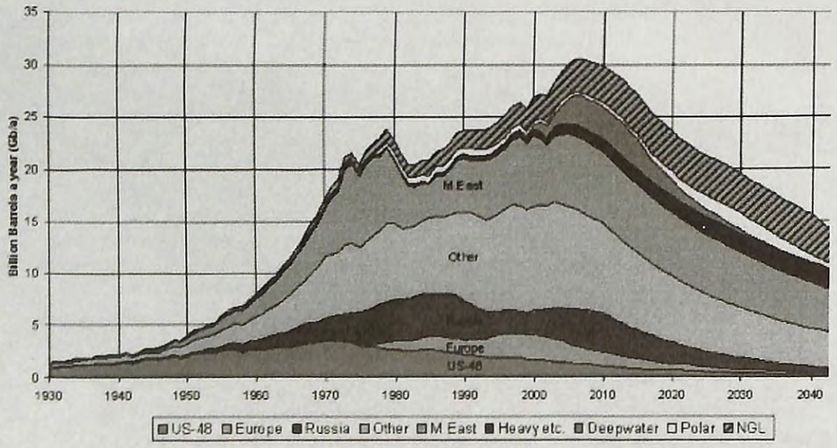
The following are some quotes from an April 2005 article entitled "Oil Production Could Peak Next Year," in the Guardian newspaper from Great Britain.

One oilman, the Oklahoma oil magnate, T. Boone Picken, has this to say: "Let me tell you some facts the way I see it. Global oil production is 84 million barrels a day [30.7 Billion barrels a year]. I don't believe you can get it any more than 84 million barrels. I don't care what (Prince) Abdullah (of Saudi Arabia), Putin or anybody else says about oil reserves or production. I think they are on decline in the biggest oil fields in the world today and I know what's it like once you turn the corner and start declining, it's a tread mill that you just can't keep up with."

Colin Campbell, an experienced oil geologist, "reckons that the global peak production of conventional oil is approaching fast, perhaps even next year."

The editor of Petroleum Review made a related remark: "Time is short and we are not even at the point where we admit we have a problem... The problem is that the peak, which I think is 2008, is tomorrow in planning terms."

OIL AND GAS LIQUIDS
2004 Scenario



The US Office of Petroleum Reserves said the following: "Although there is no agreement about the date that world oil production will peak, forecasts presented by US Geological Survey geologist Les Magoon, the Oil and Gas Journal, and other experts expect the peak will occur between 2003 and 2020... What is notable is that none extend beyond the year 2020."

Why is there such a variation in the estimate of when Peak Oil will occur?

One of the major problems is that oil reserves are not reported accurately. Colin Campbell notes that "estimates for OPEC countries were systematically exaggerated in the late 1980s to secure a greater slice of the allocation cake. Middle East reserves jumped 43% in just three years despite no major finds."

Trust in conventional oil reserve numbers is thus not very high.

Given that Peak Oil will very likely occur before 2020 and may be even occurring in the next year, what will the world substitute as conventional oil production declines?

There are several supply options that can be pursued, all of which are considerably more expensive than conventional oil.

1. Enhanced oil recovery. More oil can be extracted using advanced techniques including carbon dioxide flooding, vapour extraction, etc.
2. Tar sands and heavy oil
3. Shale oil
4. Converting coal into oil

5. Bioenergy from crop and forest materials

As I write this article, the price of oil is about $60 US a barrel and gasoline at the pumps is about 95 cents Canadian per litre in Saskatoon. Whether these prices will hold at this level in the short term is not clear. Over the long term, however, the price of oil will have to be much higher.☼

You Asked Us:

About Cold Air Returns in a Forced Warm Air Heating System

We are building a house with a forced warm air heating system and a heat recovery ventilator. I noticed that the heating contractor is putting in only two cold air returns, one on each floor of the house.

The house is two levels (1,700 sq. ft up and 1,000 sq. ft down with a 700 sq. ft crawl space. I asked about placing cold air returns in each of the five bedrooms, but was told that the two main returns were adequate and was common practice in Victoria. What is your opinion? I would have thought that returns in the bedrooms would be nicer in that not all of the air is rushing back to the central cold air returns on each floor.

You're right to raise the concern. A return into each room is a good idea, but it is only done in houses with central air conditioning. It is a matter of economics, because putting a return into each room requires more ducting, and that also means more cost.

What your builder is doing is standard practice, and does work - but it also relies on doors to rooms that are undercut, to allow air to return to the hallway where the return air grilles are located. If the interior doors were to be tightly fitted, as is standard practice in Europe, then each room should have its own return air as well - but this is rarely done here.

To match air flows without creating pressure imbalances between rooms, the standard 2'6" door would typically have to be undercut by about 1½" to allow the same amount of air to return as is being supplied by the standard 4"x10" heating register. Such a high undercut looks unsightly, and begins to raise privacy concerns, and is seldom done. Usually, the undercut is less than one inch.

The proper way to install a forced warm air heating system would be to have a return in each room — at least in each bedroom, since the bedroom doors are more likely to be closed. The assumption (and practice) is that most interior doors are open most of the time, so the undercut, in combination with open doors provides adequate return air flows.☼

NRC·CNRC

CCHT Study on Programmable Thermostats

By Marianne Manning

House temperatures are typically set by the occupants to ensure their personal comfort. When occupants are away from home, or asleep, the house temperature requirements are different. For this reason many thermostats are equipped with an automatic programming device, a simple and efficient way to reduce energy consumption at certain times of the day or week.

The National Research Council, in partnership with Canada Mortgage and Housing Corporation and Natural Resources Canada, conducted a research project in the twin houses of the Canadian Centre for Housing Technology (CCHT) in Ottawa to evaluate the effect of thermostat setback and set-forward strategies on energy consumption, the recovery period to reach the desired temperature, and the surface temperature of windows and exterior walls. The study took place in the winter of 2002/03 and in the summer of 2003.

Parameters of the Study

Since the two identical CCHT houses were built to R-2000 standards, it is possible to make comparisons by using one of them as a control house while modifying the other according to a project's objectives. In this study of programmable thermostats, the control house was maintained at 22°C all day and the other house was subjected to three temperature adjustment strategies during the winter of 2002/03:

1. night setback to 18°C (from 11 p.m. to 6 a.m.),
2. night and day setback to 18°C (from 11 p.m. to 6 a.m. and from 9 a.m. to 4 p.m.)
3. night and day setback to 16°C

During the summer of 2003, two strategies were studied: a higher temperature setting (24°C, 24 hours per day), and daytime set-forward to 25°C (from 9 a.m. to 4 p.m.).

Results and Discussion

The results of the winter trials revealed that thermostat setback presents interesting energy-saving possibilities, even in a high energy performance house. By extrapolating the results, it is predicted that winter natural gas savings could be around 6.5%, 10% and 13%, respectively, for the three strategies set out above.

Apart from saving energy, this temperature setback can affect occupant comfort and the durability of the building envelope. For example, if the recovery period (the time required for the temperature in the house to return to the original temperature) is very long, the occupants will not have the comfort level sought at the scheduled time, unless they adjust the programming hours according to these delays. In the study in the CCHT houses, the winter recovery period was relatively short, at two hours.

Moreover, if the temperature of the interior finishes, the exterior walls or the windows is too low, condensation may occur, to the extent of damaging the materials and encouraging the growth of mould. The window components were monitored continuously during the study and the results showed that condensation or frost should be expected in the lower part of the window in very cold weather unless the relative humidity rate is below 19% at 22°C. In these houses, the window ledge surface temperature fell below 0°C, even in the control house maintained at 22°C.

The savings from the setback strategy manifested themselves mostly in colder weather (say below 0°C). Because the twin houses were built to the R-2000 standard, they don't cool off fast enough in milder weather to achieve appreciable savings due to the setback strategy. So if the identical houses were built in Vancouver, for example, we would expect greatly reduced savings.

The results of the summer trials indicate that daytime temperature set-forward is not necessarily the most effective strategy for air conditioning. Fan and air conditioner electrical consumption depend on solar radiation. Indeed, if every summer day were sunny, the daytime set-forward from 22°C to 25°C would produce electrical energy savings of 13.2%. However, if every day were cloudy, these seasonal savings would be reduced to 2.9%. In addition, the recovery times resulting from the temperature set-forward strategy turned out to be much longer: up to seven hours on the hottest days, the same length of time as the set-forward itself. This can have a negative influence on occupant comfort in the evenings. ☼

This article is based on the final project report, which can be downloaded from the Internet at *http://irc.nrc-cnrc.gc.ca/fulltext/rr191/* (in English).

For more information on projects and publications related to the research of the Canadian Centre for Home Technology (CCHT), visit *www.ccht-cctr.gc.ca*

Marianne Manning is a technical officer at the NRC Institute for Research in Construction. She can be reached at: marianne.manning@nrc-cnrc.gc.ca

Are we cutting too many corners? Who are the real tin bashers?

The trades working on sheet metal for forced warm air heating and ventilation systems have come to be affectionately known as tin bashers.

We've heard it said that now with the reduction in sheet metal thickness used in sheet metal ducting, from a 30 gauge - or 0.013" thick metal to a 0.010" thick, the real tin bashers are the plumbers, electricians and all others who follow after the sheet metal ducts have been installed.

The problem with the thinner metal is that it is so thin it is not able to take the kind of abuse that can happen on a site. The thinner metal even makes it harder to screw sections and fitting together, as there is so little material.

Has the industry gone too far to shave a few pennies? ☼

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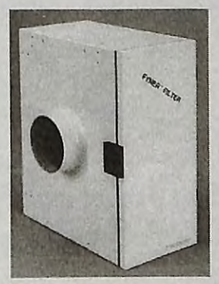

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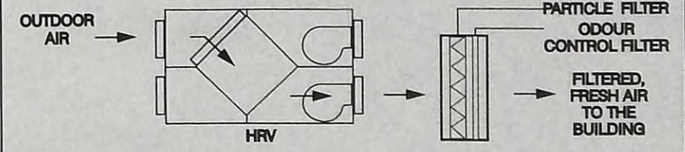

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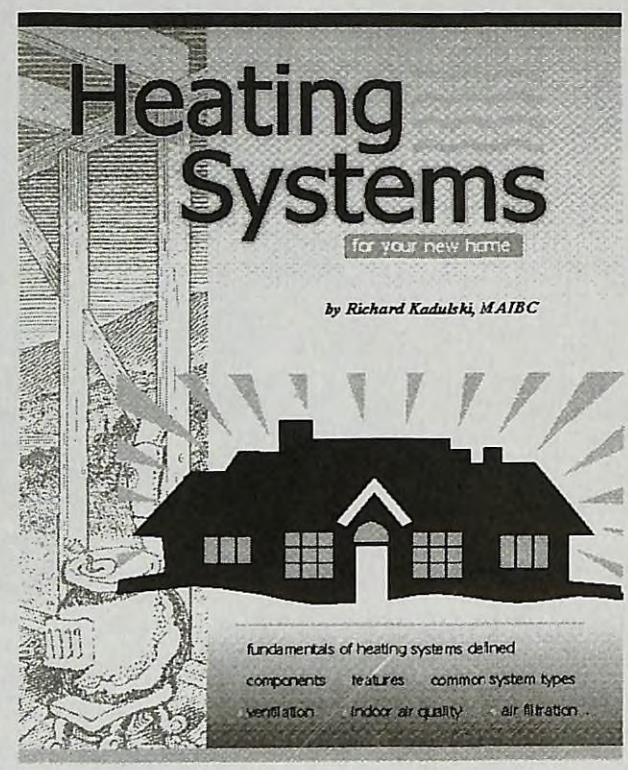
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